The main focus of this thesis work has been the study of domain wall (DW) dynamics in disordered cylindrical nanomagnets. The study attempts to accurately quantify the stochasticity associated with driven (temperature/magnetic field/spin-torque) DW kinetics. Our results as summarized below, are particularly relevant with regard to the technological advancement of DW based magnetoelectronic devices.

1. Temperature dependent noise measurements showed an exponential increase in noise mag-nitude, which was explained in terms of thermally activated DW depinning within the Neel-Brown framework. The frequency-dependence of noise also indicated a crossover from nondiffusive kinetics to long-range diffusion of DWs at higher temperatures. We also observed strong collective depinning, which must be considered when implementing these nanowires in magnetoelectronic devices.

2. Our noise measurements were sensitive enough to detect not only the stochasticity in DW propagation (diffusive random walk) but also their nucleation in the presence of magnetic field down to a single DW unit inside an isolated single Ni nanowire. Controlled injection and detection of individual DWs is critical in designing DW based memory devices.

3. The spectral slope of noise was observed to be sensitive to DWkinetics that reveals a creep-like behavior of the DWs at the depinning threshold, and diffusive DW motion at higher spin torque drive. Different regimes of DW kinetics were characterized by universal kinetic exponents. Noise measurements also revealed that the critical current

density and DW pinning energy can be significantly reduced in a magnetically coupled vertical ensemble of nanowires. This was attributed to strong dipolar interaction between the nanowires. Our results are particularly important in view of recent proposals for low power consumption magnetic storage devices that rely on DW motion.

In all our experiments, the critical magnetic field/current density, required to set the DWs in duffusive kinetics, were found to be much smaller than the reported values for nanostrips. This could be attributed to the circular cross section of nanowires, where massless DWs results in the absence of Walker breakdown and hence in zero critical current density. At present the contribution from the non-adiabaticity, which acts as an effective field and can reduce the crit- ical current density, can not be denied. The main di±culty in quantifying the non-adiabatic spin-torque is that not only does it contain contributions due to non-adiabatic transport but also due to spin-relaxation provided by magnetic impurities or the sources for spin-orbit scattering. Fortunately, in cylindrical nanomagnet, non-adiabaticity does not affect the DW motion. There- fore, cylindrical NWs may be promising candidate for future magnetic storage devices. However, a systematic experimental study of DW dynamics in cylindrical nanomagnets is lacking.

In chapter 7, silver nanowires (AgNWs) are shown to be stabilized in fcc or hcp crystal structure, depending on the electrochemical growth conditions. The AgNWs stabilized in hcp crystal structure are shown to exhibit exotic structural properties i.e. ultra low noise level, thermally driven unconventional structural phase transformation, and time dependent structural relaxation. Ultra noise level makes hcp AgNWs suitable for application in nanoelectronics and the structural transformation may be exploited for use in smart materials. Though time resolved transmission electron microscopy and noise measurements provide some understanding of the hcp AgNWs formation, the precise growth mechanism is still not clear.

Future scope of the work

The results in this thesis provide the groundwork for a good understanding of stochastic DW kinetics in isolated as well as ensemble of magnetic nanocylinders. Some extensions to this work that would help expand and strengthen the results, are listed below;

1. In all the nanocylinders used for our experiments the source of stochasticity in DWkinetics were randomly distributed structural defects. For a controlled injection and detection of DWs between the voltage probes, it would be of great importance to fabricate artificial notches (pinning centers) in the NW. These notches can be fabricated either by using nano-indentation or by a focussed ion beam.

2. To investigate whether DWs in different parts of the nanowire exhibit spatio-temporal correlation, a simultaneous detection of DWkinetics (through noise measurement) between different volage probes needs to be done. If the propagation time of DWs scales with the distance between the voltage probes, we can be confident of our velocity measurement. Then, by recording the DWvelocity as function of eld/current for nanowire (or nanostrip) absence (or presence) of the Walker breakdown can be probed. This would be a significant result for future spintronic devices. With an

accurate determination of velocity even non- adiabaticity parameter may be calculated and one can see its effect on DW dynamics.

3. A complete understanding of sustained avalanches at finite magnetic fields, characterized by a high spectral exponent (a>¸ 2:5) in an ensemble of nanowires is still lacking. Per- forming a controlled experiment on a single nanowire, by varying the number of nanowires in the alumina matrix, one can study the chaotic dynamics of DWs in the ensemble in very accurate manner.

All the experiments on AgNWs were performed on ensembles. The large change in a as well as noise magnitude in hcp AgNWs could arise from stress relaxation due to the presence of an insulating matrix or structural relaxation, determined by the nanowire growth kinetics. To resolve this issue, time and temperature dependent noise measurements should be performed on single nanowire stabilized in both hcp and fcc crystal structure.